



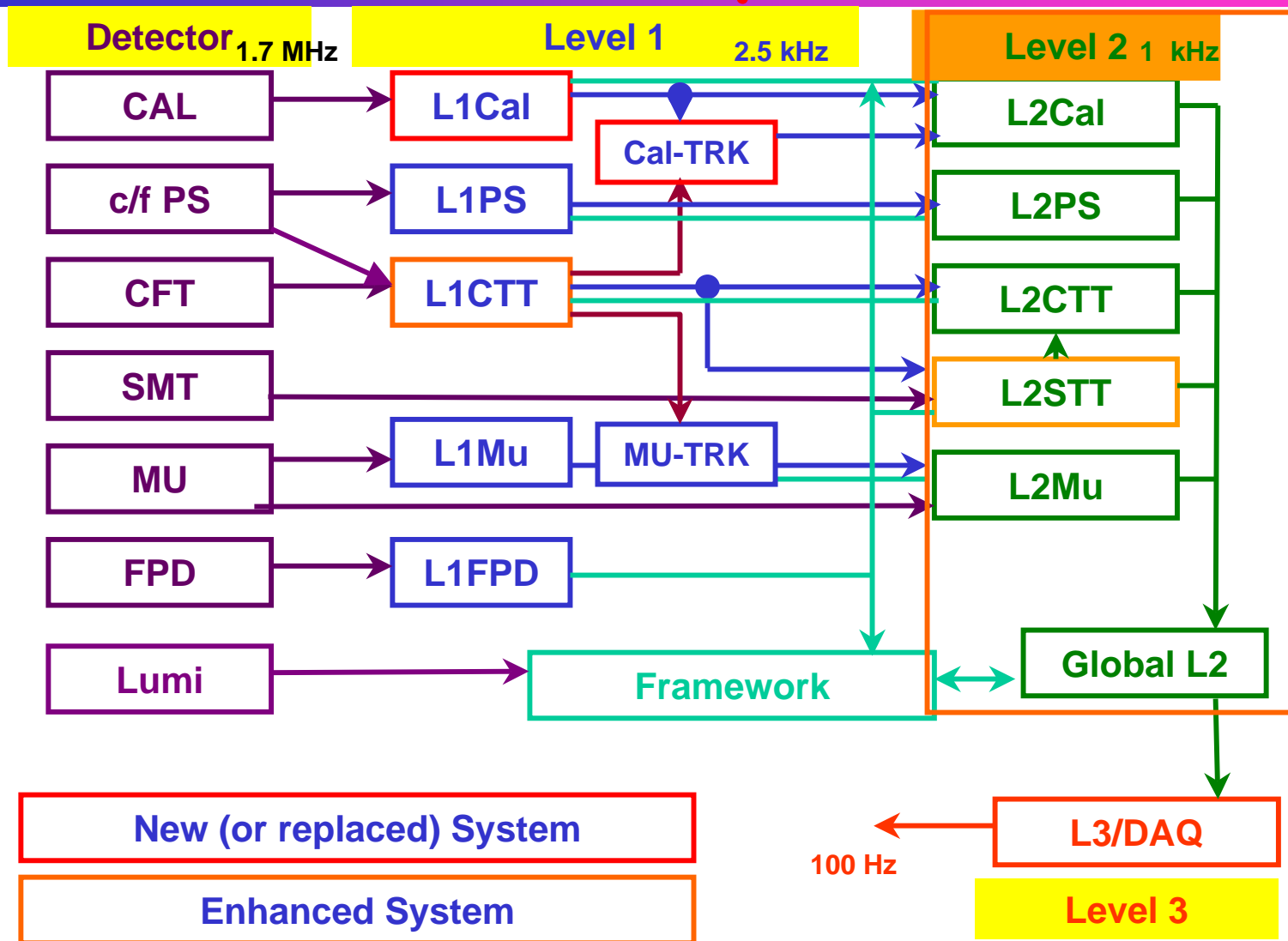
Trigger Upgrade Preparations

- General description and strategy
- Status by subsystem

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For the DØ Trigger Upgrade



The Run IIb Trigger System





Trigger Upgrade Overview

- The DØ Trigger Upgrade consists of
 - ◆ Complete replacement of Level 1 calorimeter trigger (legacy system from Run 1)
 - ◆ Replacement of the DFEA's (track finding modules) in the Level 1 Central Track Trigger
 - ◆ A new Level 1 system to match calorimeter objects and tracks (L1caltrack)
 - ◆ Upgraded/additional processors for the Level 2 trigger (L2beta)
 - ◆ Incorporation of Layer 0 into the Level 2 Silicon Track Trigger (L2STT)



General Strategy in preparing trigger upgrade for installation

- Bench test all individual components
 - ◆ Completed months ago in most cases
 - ◆ Includes thorough exercising in test stands
- Do substantial system integration prior to installation – minimize commissioning time – examples:
 - ◆ L1CTT: new crate in collision hall (parallel readout with Run2a system)
 - ◆ L1cal: sidewalk test stand (parallel readout with Run2a system)
 - ◆ L1Caltrack – exercise in situ
 - ◆ L2beta: run processors in shadow mode



Project Reviews

- Each major board in the trigger system had a Production Readiness Review (PRR) before releasing it for production
 - ◆ L1cal: TAB/GAB - Oct/04
 - ◆ L1cal: ADF - Feb/05
 - ◆ L1caltrk - Jul/03
 - ◆ L1CTT: crates & controllers - May/04
 - ◆ L1CTT: DFEA2 - Jan/05
 - ◆ L2beta - May/05
 - ◆ L2STT - Sep/04
- In addition, the two largest systems (L1cal, L1CTT) each had a Technical Readiness Review (TRR)
 - ◆ review system integration - functioning of the parts as a coherent whole
 - ◆ evaluate system readiness for installation



L1CTT Status



← 2 full crates (full system) in test stand

1 full crate installed on platform ↓



- New crate, new controller, and 2 new DFEA2's have been running in parallel with RunIIa CTT since end of 2004
 - ♦ DFEA and DFEA2 results are in exact agreement for same (doublet) equations
 - ♦ Now running production DFEA2 with singlet equations
- Two Full two crates (40 cards = full system) were run in the tests stand at FNAL
- Stand-alone testers set up at BU and FNAL
 - ♦ Ran 1.5 M test vectors through one board (3 days), 20k vectors through 49 boards, without errors
 - ♦ Bit Error rate on LVDS links $< 10^{-16}$



TRR Highlights: L1CTT

- L1CTT Technical Readiness Reviews (TRR)
29-Jul-05:
 - ◆ Reviewers: Marj Corcoran (chair), Ken Johns, Mike Matulik, Brigitte Vachon
 - ◆ Summary from report: "All of the major parts of the L1CTT upgrade are complete and ready for installation. Having the system completed a few months before installation allows time for system-level tests. Several system tests have been performed with no serious problems discovered. We suggest additional tests which might be informative, but we did not feel that any of these tests were essential before installation."



Strategy: L1CTT

- Installation on platform requires access to collision hall
 - ♦ nominal plan requires eight weeks (no beam), including lots of checking and testing
 - see S. Grünendahl talk
- Prior to the shutdown, additional development of online monitoring and offline analysis tools will continue in an effort to minimize post-installation commissioning time
- Re-test all DFEA2 boards shortly before installation



L1cal: TRR Highlights

- Two-day review (26-27 Aug)
- **Committee:** Norm Buchanan, Bob DeMaat, Bob Hirosky (chair), Dean Schamberger ("at large"), Marco Verzocchi, Taka Yasuda
- **Summary:**
 - ◆ "The committee feels that the L1CAL system is well on track to begin installation on Oct. 31. The remaining tasks to complete the system are well understood by the L1CAL group. In this report we have noted the tasks that should be pursued with highest priority to complete the remaining checks of the system and to prepare for installation..."



L1cal: Integration

- “Sidewalk” test stand allows
 - ◆ Setup of full system (all cards and crates)
 - ◆ Readout and triggering as part of regular DØ DAQ
- System can be exercised with
 - ◆ Up to 16 channels of real split analog inputs
 - ◆ all 2560 channels of programmable test inputs
 - ◆ “examine” program to analyze events passing trigger
 - ◆ power supply monitors
 - ◆ data spying monitors



L1cal test stand on sidewalk by MCH1

4-tower splitter installed in MCH1

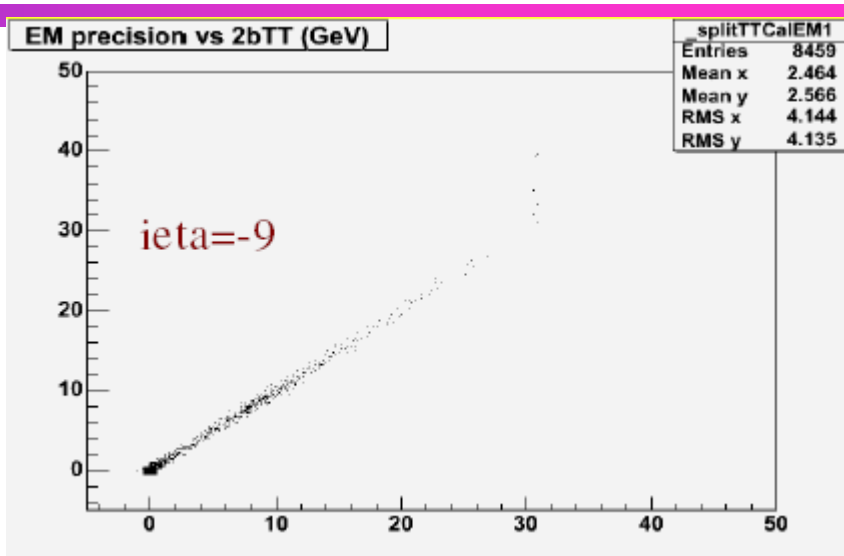




L1cal Status

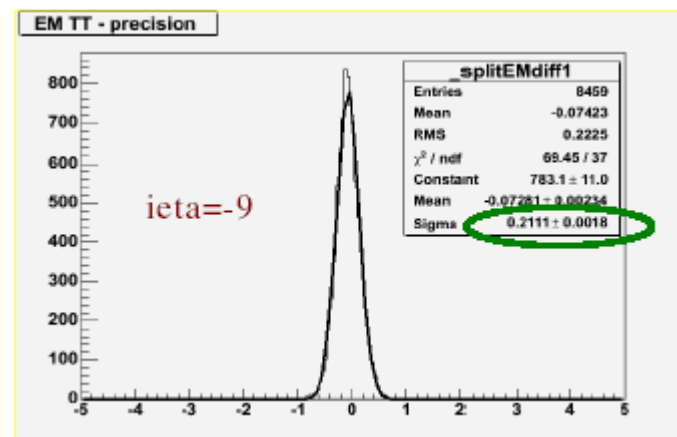
- All intra- and inter-system links tested and operational
- Measured latency in general agreement with predictions
- Parallel data taken with splitters
 - ◆ compared with precision readout and with RunIIa L1cal
 - ◆ good agreement with RunIIa resolutions
- Utilities exercised to compare hardware with sliding-windows simulation

Prec. RO energy (GeV)



RunIIB TT energy (GeV)

Comparison
of RunIIb
Trigger
Tower Et
with
precision
readout



RunIIB TT – Prec. (GeV)



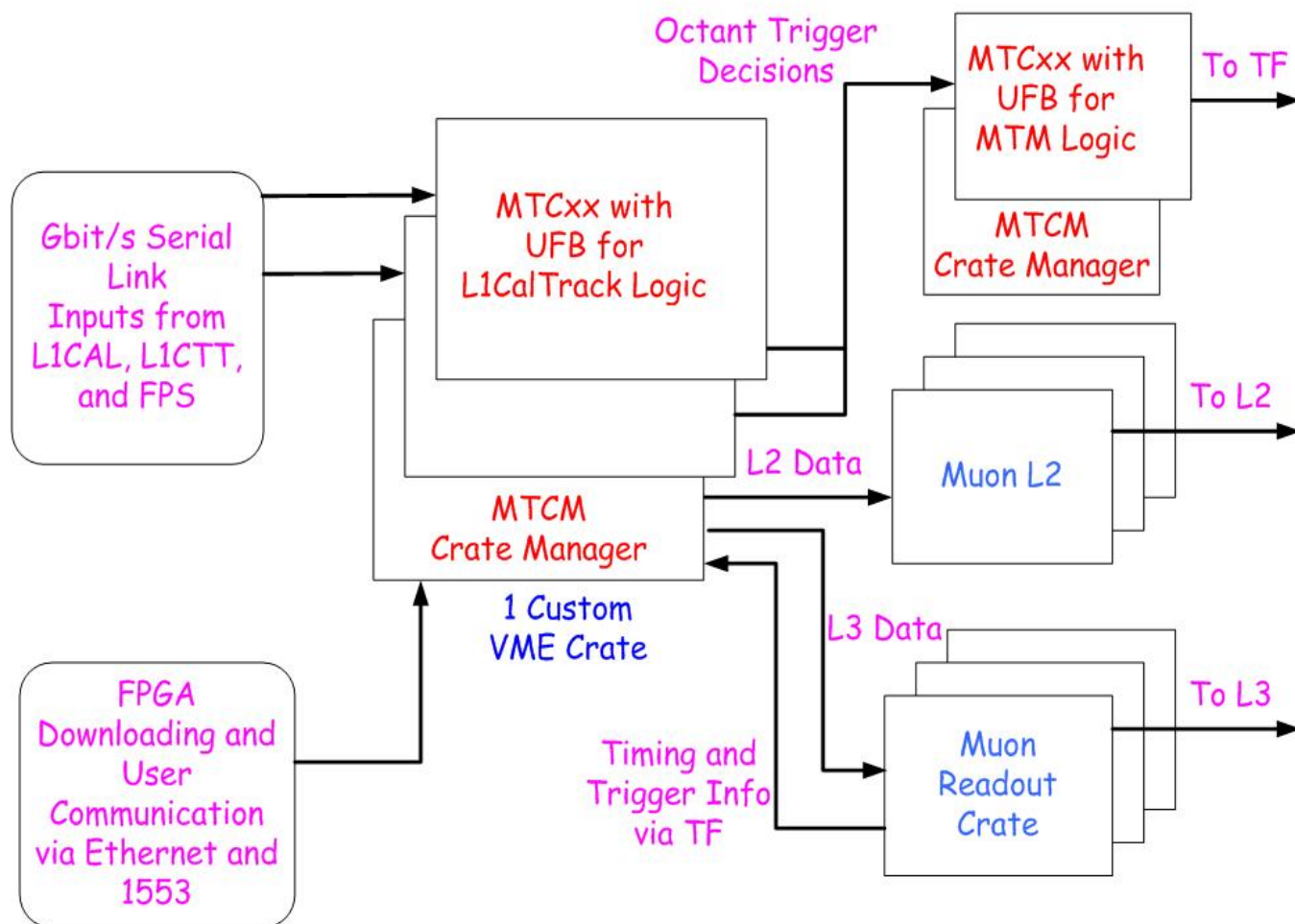
L1cal - now until installation

- To do: complete the (few) remaining items on the list prepared for the Oct 31 shutdown
 - ◆ run all 80 ADF's
 - ◆ Run all 8 TAB's
 - ◆ GAB triggers to Trigger Framework
 - ◆ complete transition system
- Complete more extensive list of core functionality to attain a stable operation state by ~Nov 15th
 - ◆ Minimizes post-installation commissioning period by routinely incorporating the entire L1Cal upgrade system (with very limited inputs) into data acquisition
 - ◆ Exercises full functionality of hardware and software, online controls, online monitoring, diagnostic software, offline software, pulser and simulation
 - ◆ maintains strong commissioning team momentum
- Goal is to transfer routine operation and monitoring of the L1Cal trigger electronics to the CALMuo control room shifter, with expert support provided by L1Cal Upgrade team



L1CalTrack System

L1CalTrack Trigger System





L1CalTrack Status

- Trigger hardware complete and tested
 - ◆ 16 MTCxx trigger cards
 - ◆ 6 MTCM trigger manager cards
 - ◆ 14 UFB flavor boards
 - ◆ 14 splitter cards
- Trigger infrastructure complete
 - ◆ 2 VME crates and power supplies
 - ORC document in preparation
 - ◆ On-board and off-board cables
 - Off-board cables from L1Cal and L1CTT need eye pattern testing
- Installation complete (but inputs not connected)



L1CalTrack Status (cont.)

- Trigger firmware and software
 - ◆ Trigger control firmware complete
 - ◆ Trigger algorithm firmware complete
 - ◆ Cold start and download GUI complete
 - ◆ Monitoring GUI's ~50% complete
 - ◆ L1CalTrack algorithm code exists
 - ◆ L1CalTrack trigger simulator code exists
 - ◆ L1CalTrack data unpacking code exists
 - ◆ Online examine not started (but builds on above)



L1CalTrack Status & Plans

- **Pre-commissioning: Done**
 - ◆ L1 triggers generated using Muon FE (test), L1CTT and L1Cal inputs
 - ◆ L1CalTrack trigger and manager crates readout into L3
 - ◆ L1CalTrack data collected for unpacking tests
- **Priorities: To do**
 - ◆ Complete ORC
 - ◆ Complete monitoring GUI's and online examine
 - ◆ Full crate tests
 - ◆ Include L1CalTrack readout for several stores
 - ◆ Eye pattern test off-board L1Cal cables
 - ◆ Continue electron and tau algorithm development



Status & Strategy: L2beta

- Purpose: boost CPU power in Level 2 trigger to accommodate more demanding conditions of high luminosity running
 - ◆ larger events (multiple interactions)
 - ◆ enriched event sample due to level 1 improvements
 - ◆ more sophisticated algorithms
- All hardware complete and tested
 - ◆ new L2beta processor currently running in L2CTT
 - ◆ full complement completed testing in August at UVa
- Plan to install new processors this Fall
 - ◆ no access necessary
 - ◆ installation between stores
 - ◆ no interruption of data taking expected



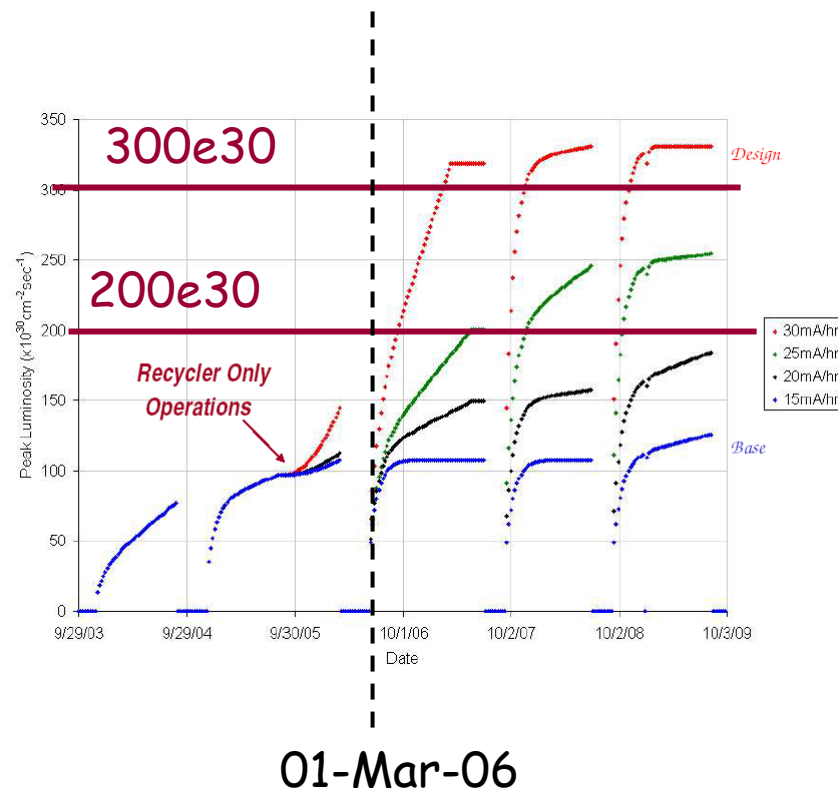
Status & Strategy: STT

- Purpose of upgrade: include SMT Layer 0 in Level 2 Silicon Track Trigger
- Hardware production and testing complete
 - ♦ copies of same modules currently in service in the STT
- Nothing gained from STT upgrade until Layer 0 is installed, so wait
- In mean time, update STT simulation (new manpower coming on board next month) and then test firmware changes



Simulation and Trigger List Development

- Tools developed
 - ◆ “Trigsim”: full simulation of Run2a and Run2b trigger hardware
 - ◆ “Trigger Rate Tool”: executes trigger algorithms on real data to predict rates of full trigger list
- “Version 15 Task force” tuning first trigger list for post-shutdown running
 - ◆ trigger board chair (M. Verzocchi) plus Run2a and Run2b trigger experts
 - ◆ designing for $L=200\text{e}30$ and $300\text{e}30$





Trigger latency adjustment

To accommodate latency of the upgraded L1 trigger, the overall L1 trigger latency must be increased

- Original specification: increase from 3300 ns to 4092 ns
 - ♦ Increase of 6×132 ns ("six ticks")
 - ♦ critical timing path is L1cal-to-L1caltrack-to-TFW
- Recent measurements: increase needed only ~3 ticks
 - ♦ This could simplify work for some subsystems (Cal)
 - ♦ Full measurement with final timing scheduled this week
- Changes required in other subsystems to accommodate latency
 - ♦ Simple parameter download (luminosity)
 - ♦ Firmware change (Trigger Framework, Muon MDT, Muon Scint, Cal, CFT, CTT, SMT)
 - ♦ Hardware (+ firmware) modification: Muon PDT
 - One modified control board in place in detector and operational since 10/18
- Plan to come out of shutdown with old timing then switch shortly afterwards
 - ♦ allows verification of subsystem operations
 - ♦ postpones use of L1caltrack in trigger until after timing change



Trigger pre-installation strategy: Summary

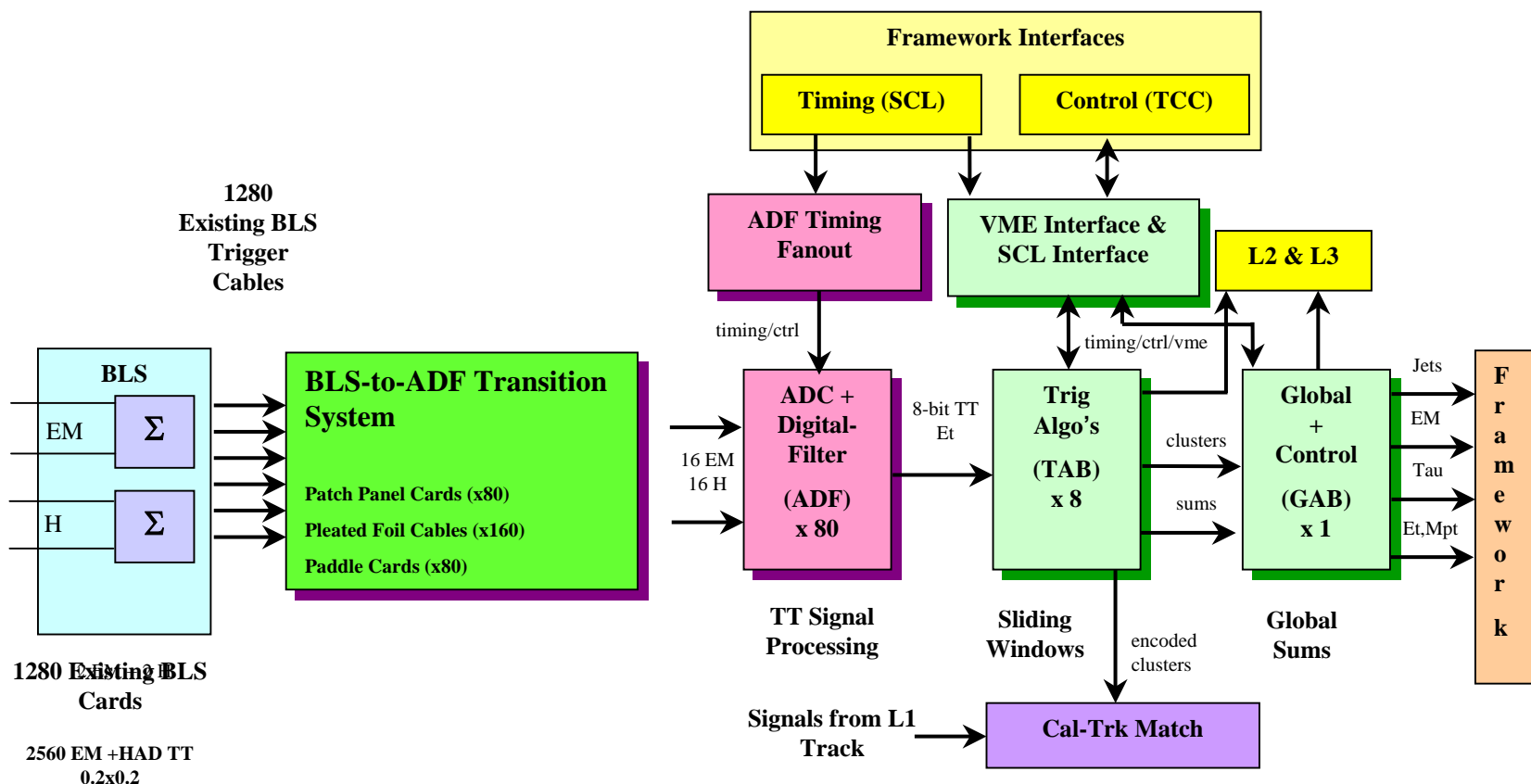
- General strategy
 - ◆ still try to finish as much as possible of any remaining preparations in next few weeks
 - ◆ use extra 4 months to
 - minimize eventual commissioning time by in-situ tests and polishing of debugging tools
 - get some systems into routine mode requiring reduced expert intervention
- Try to make sure we have adequate personnel and expertise available when needed (now, installation, post-installation commissioning)
- Where possible, try to work now to reduce commissioning time later



Backup slides follow



Hardware - L1cal





Latency: Work required by subsystems

- Simple parameter download:
 - ♦ Luminosity
- Firmware change:
 - ♦ Trigger Framework, Muon MDT, Muon Scint, Calorimeter, CFT, CTT, SMT
 - Cal FPGA code written for $+3 \times 132$ ns (also for $+6 \times 132$ ns), tested on 5000-channel test stand
 - $+3 \times 132$ pipeline settings tested for CFT in August - looks OK
- Hardware (+ firmware) modification:
 - ♦ Muon PDT
 - One modified control board in place in detector and operational since 10/18
 - Total 94 boards must be swapped in opportunistic accesses + shutdown
 - Modified boards will work with new or old framework timing
- Plan to come out of shutdown with old timing then switch shortly afterwards
 - ♦ allows verification of subsystem operations
 - ♦ postpones use of L1caltrack in trigger until after timing change